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THE EFFECT OF TEMPERATURE CYCLING TYPICAL OF LOW EARTH ORBIT SATELLITES ON THIN FILMS OF $YBa_2Cu_3O_{7-x}$

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The refrigeration of superconductors in space poses a challenging problem. The problem could be less severe if superconducting materials would not have to be cooled when not in use. Thin films of the $YBa_2Cu_3O_{7-x}$ (YBCO) superconductor were subjected to thermal cycling, which was carried out to simulate a large number of eclipses of a low earth orbit satellite. Electrical measurements were performed to find the effect of the temperature cycling.

Thin films of YBCO were formed by coevaporation of Y, BaF_2, and Cu and postannealing in wet oxygen at 850°C for 3.5 h. The substrates used were (100) $SrTiO_3$, polycrystalline alumina, and oxidized silicon; the last two have an evaporated zirconia layer. Processing and microstructure studies of these types of films have been published (1-4). The zero resistance transition temperatures of the samples used in this study were 91, 82, and 86 K, respectively. The samples were characterized by four point probe electrical measurements as a function of temperature. The parameters measured were: the zero resistance transition temperature (T_c), the 10 to 90% transition width (ΔT_c), and the room temperature resistance, normalized to that measured before temperature cycling (R_N).

The results for two samples are shown in Figures 1 and 2. Each sample had a cumulative exposure. The temperature cycling stages referred to in the figures are as follows:

1. Before temperature cycling.
2. After 5 cycles at ± 50°C in vacuum.
3. After an additional 200 cycles at ± 50°C in vacuum.
4. After an additional 200 cycles at ± 60°C in nitrogen.
5. After an additional 200 cycles at ± 80°C in nitrogen.

Cycling in atmospheric pressure nitrogen was performed at a rate of about 60 cycles per day, whereas in vacuum the rate was only about 10 cycles per day.

The results indicate only little or no changes in the parameters measured. T_c remains constant; R_N increases at first but seems to stabilize, indicating an ~ 10% increase in Fig. 1, and an ~ 20% increase in Fig. 2; ΔT_c is unchanged in Fig. 1, and increases by about one degree in Fig. 2.

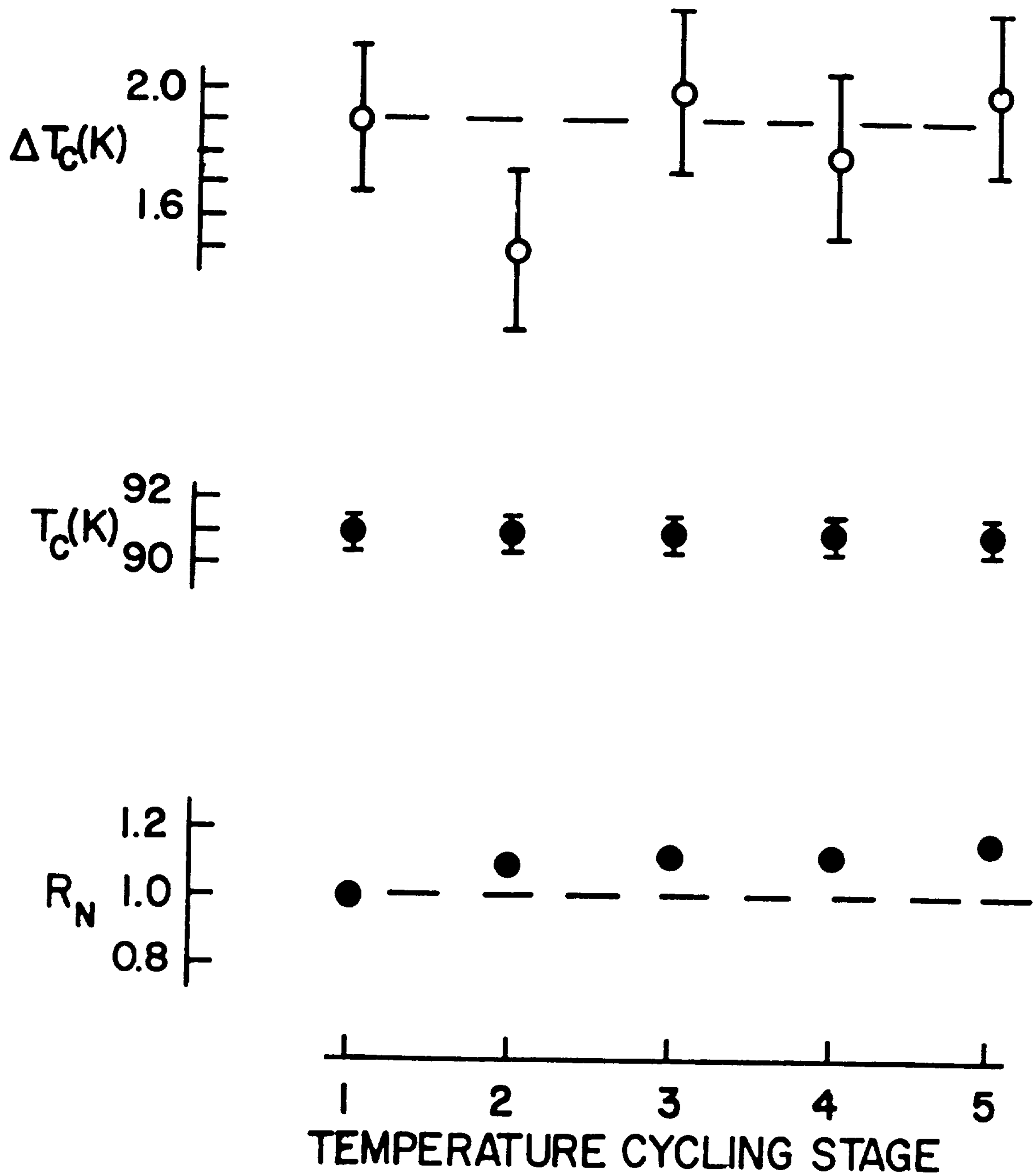

Figure 1. Electrical parameters measured after each cycling stage (defined in the text) for a YBCO thin film on (100) $SrTiO_3$

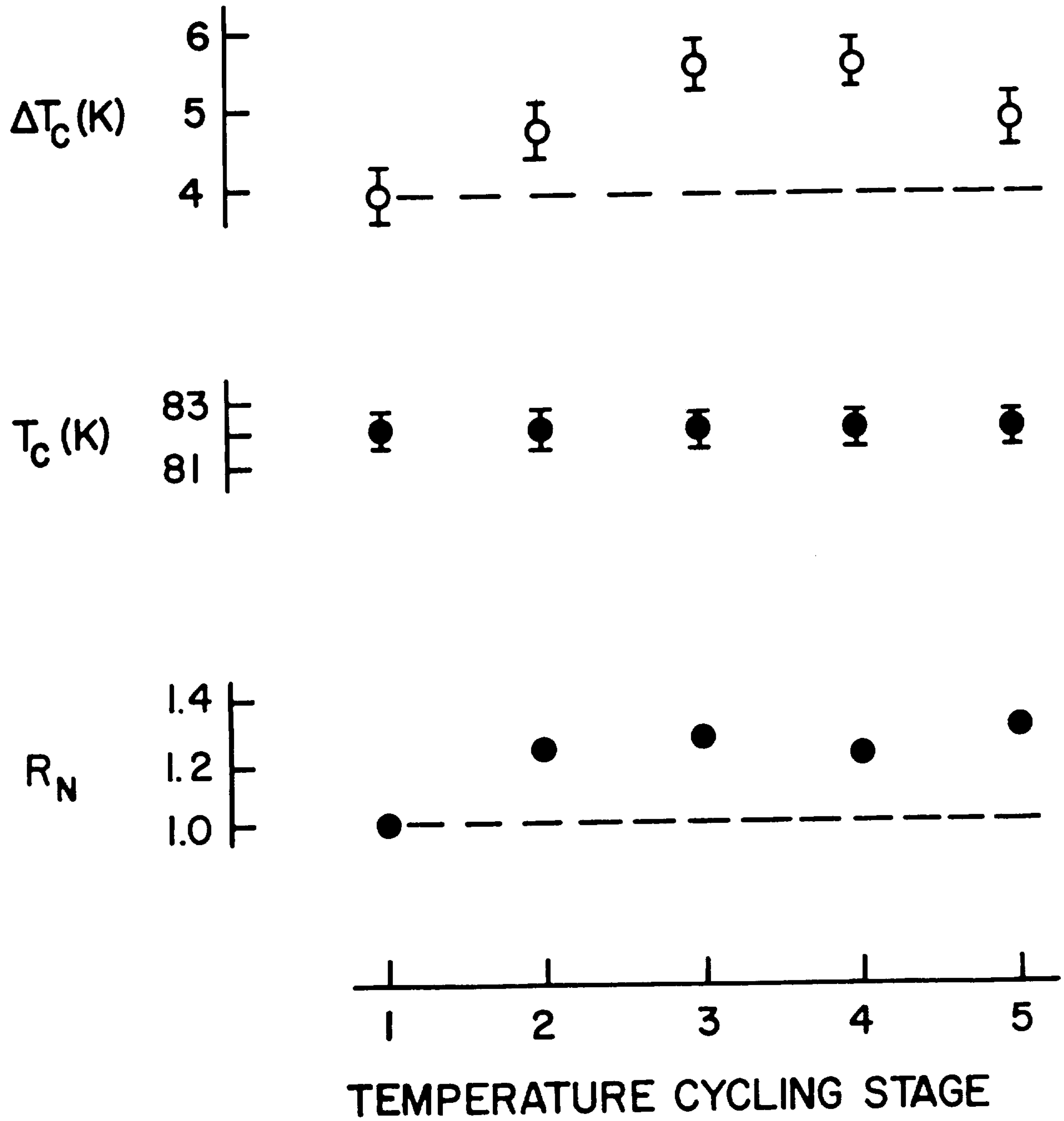

Figure 2. Electrical parameters measured after each cycling stage (defined in the text) for a YBCO thin film on polycrystalline alumina with a zirconia buffer layer.

Degradation of superconducting thin films of YBCO has been reported due to storage in nitrogen (5). We believe that the relatively good performance of our films after temperature cycling is related to the fact that BaF_2 was used as an evaporation source (6).

Our latest result on extended temperature cycling (3500 cycles at $\pm$ 80°C in nitrogen) indicates significant degradation. Further tests of extended cycling will be carried out to provide additional data and to clarify this preliminary finding.

References

1. A. Mogro-Campero and L.G. Turner, Appl. Phys. Lett. 52, 1185 (1988).

2. A. Mogro-Campero, L.G. Turner, E.L. Hall, and M.C. Burrell, Appl. Phys. Lett. 52, 2068 (1988).

3. A. Mogro-Campero, and L.G. Turner, Supercond. Sci. Technol. 1, 269 (1989).

4. A. Mogro-Campero, L.G. Turner, and G. Kendall, Appl. Phys. Lett. 53, 2566 (1988).

5. B.Y. Tsaur, M.S. Dilorio, and A.J. Strauss, Appl. Phys. Lett. 51, 858 (1987).

6. P.M. Mankiewich, J.H. Scofield, W.J. Skocpol, R.E. Howard, A.H. Dayem, and E. Good, Appl. Phys. Lett. 51, 1753 (1987).